National Transportation Safety Board
Aviation Incident Final Report

Location:	Chicago, IL	**Incident Number:**	CHI08IA026
Date & Time:	10/09/2007, 2030 CDT	**Registration:**	N431UA
Aircraft:	Airbus Industrie A320-232	**Aircraft Damage:**	Minor
Defining Event:		**Injuries:**	2 Minor, 125 None
Flight Conducted Under:	Part 121: Air Carrier - Scheduled		

Analysis

The airplane's left main landing gear inboard and outboard anti skid tachometers wiring were reversed during scheduled maintenance at a vendor. During landing, the inboard left main landing gear's wheels went to a high braking level and the outboard wheel did not apply braking. The airplane sustained minor damage when it exited the runway and impacted runway lighting. Post incident examination of the airplane and brake components revealed no further anomalies. The vendor that performed the scheduled maintenance indicated that their personnel did not understand that the built in test equipment test they performed did not check for cross-wired tachometers. A different specified test called out in the airplane maintenance manual and in an operator's reference document indicated this specified check would verify a cross-wired condition. The operator reported that the reference documentation associated with the scheduled maintenance involving both of the left main landing gear's tachometers was unclear and that the procedure for that maintenance was revised.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this incident to be: The misrouted and reversed antiskid wiring by vendor maintenance personnel leading to the runway excursion. Contributing to the incident were the runway sign, the vendor's maintenance personnel not understanding the entire maintenance procedures in the dual tachometer replacement, and the operator's maintenance procedures being unclear to the maintenance personnel.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION
Phase of Operation: LANDING

Findings
1. (C) LANDING GEAR,ANTI-SKID BRAKE SYSTEM - MISROUTED
2. (C) BRAKES,ANTI-SKID - REVERSED - OTHER MAINTENANCE PERSONNEL
3. (C) LANDING GEAR,NORMAL BRAKE SYSTEM - LOCKED
4. (F) INTERPRETATION OF INSTRUCTIONS - NOT UNDERSTOOD - OTHER MAINTENANCE PERSONNEL
5. TERRAIN CONDITION - RUNWAY
6. (F) INSTRUCTIONS,WRITTEN/VERBAL - INFORMATION INSUFFICIENT - COMPANY/OPERATOR MANAGEMENT

Occurrence #2: ON GROUND/WATER COLLISION WITH OBJECT
Phase of Operation: LANDING

Findings
7. (F) OBJECT - RUNWAY LIGHT

Factual Information

HISTORY OF FLIGHT

On October 9, 2007, about 2030 central daylight time an Airbus Industrie A320-232, N431UA, operated by United Airlines (UA) as flight 628, received minor damage when it exited runway 22R (7,500 feet by 150 feet, grooved asphalt) and impacted runway lighting at the O'Hare International Airport (ORD), Chicago, Illinois. Two pilots, 2 flight attendants, and 121 passengers were uninjured. One flight attendant and one passenger reported minor injuries. The 14 CFR Part 121 scheduled domestic passenger flight was being conducted in night visual meteorological conditions. An instrument flight rules flight plan was filed and activated. Flight 628 departed the Seattle-Tacoma International Airport, near Seattle, Washington, about 1649, and was destined for ORD.

The captain said that the preflight, taxi, takeoff, and cruise portions of the flight were uneventful. The autobrakes were set to low prior to the approach. The captain's incident report, in part, stated:

> Approach was stabilized to touchdown with about one-half dot low deviation at about 500 ft, correcting back to glide slope prior to touchdown. Tower reported winds just prior to touchdown as 300/13. Touch down was in the landing area, somewhat harder than anticipated. Reverse Thrust was initiated, but there appeared to be no autobraking.
>
> Approximately 1500-1000 feet prior to intersection of taxiway C, I checked airspeed, waited a couple counts for the airspeed to drop below 100 kts and commenced braking. The aircraft immediately swerved hard right. I corrected with full left rudder and brake, but aircraft continued to the right. I then used Nose Wheel Steering to attempt to straighten the aircraft, but it was ineffective. At that time the aircraft left the right side of the runway, parallel to the runway, contacted at least one sign, and then began to track left, back onto the paved surface. Aircraft stopped on runway and taxied clear at [taxiway] R.
>
> Although I knew there was some aircraft damage, there was no indication of fire. Since the aircraft taxied normally, I taxied to gate B-10 and parked at the gate.
>
> At the gate, brake temp indications showed no temp rise on the left brakes (indicating about 60 degrees), while the right brakes were in

the overheat temperature about 375 degrees. At that point maintenance arrived and said there was damage to the engine nacelles and the left inboard tire was blown.

The first officer's incident report, in part, stated:

Captains leg on landing 22R wind 300/17G23 on the ATIS. Briefed a flaps 3 landing for the crosswind. Firm touchdown in the landing zone. Spoilers deployed and reverse activated. We were coming up to C still above 80 knots. Applied brakes firmly and plane swerved to the right. Checked to make sure captain had full left rudder and full left brake. He did. As we departed the right side of the runway saw the Captain was using steering to get us back on. He did. The right Main and nose wheel exited the runway. Once stopped back on the runway we informed tower of our excursion from the runway. They told the plane behind us to go around. We determined that we could taxi ok and decided we could clear the runway. Once clear it felt like it was taxiing ok so we continued to the gate. We left the flaps and spoilers in position in case of damage. The left brake temps were around 60 degrees like they never came on and the right were 390. I forgot to add that we had the auto brakes set to LO. Neither of us felt them engage on the rollout.

INJURIES TO PERSONS

According to the operator, one flight attendant and one passenger went to a hospital for examination. The attendant and passenger subsequently released themselves from the hospital.

PERSONNEL INFORMATION

The captain held an airline transport pilot certificate with an airplane multiengine land rating and held airplane single engine land commercial privileges. He held a flight engineer certificate. The captain held type ratings in Airbus A-320, Boeing 757, 767, 777, and Gulfstream Aerospace Corporation-1159 airplanes. The operator reported that the captain had accumulated about 14,250 hours of total flight experience, which included 2,450 hours in the Airbus A-320. The operator reported that the captain's most recent Federal Aviation Administration (FAA) first class medical certificate was issued on April 27, 2007. His last check ride was completed in June 2007.

The first officer held an airline transport pilot certificate with an airplane multiengine land

rating and held airplane single engine land commercial privileges. He held a flight engineer certificate. The first officer held type ratings in Airbus A-320, Learjet, and Learjet-45 airplanes. He had held a certified flight instructors certificate with single engine, multiengine, and instrument airplane ratings. The operator reported that the first officer had accumulated about 10,206 hours of total flight experience, which included 268 hours in the Airbus A-320. The operator reported that the first officer's most recent FAA first class medical certificate was issued on March 15, 2007. His last check ride was completed in July 2007.

AIRCRAFT INFORMATION

N431UA, an Airbus Industrie A320-232, serial number 571, was a pressurized, low-wing, transport category airplane. The airplane had a full-cantilevered wing and tail surfaces, a semi-monocoque fuselage, and a fully retractable tricycle landing gear. The two wing-mounted IAE 2527 turbofan engines each produced 26,500 lbs of thrust. The airplane was configured to accommodate 138 passengers and 8 crewmembers. The airplane had a reported maximum gross takeoff weight of 169,750 lbs.

The airplane was being maintained by compliance with a FAA approved continuous airworthiness program. The airplane's last inspection was completed on 10/8/07. According to the operator, the airplane had accumulated 41,163 hours total time in service at that inspection.

The airplane was equipped with brakes and anti-skid system. The section on that system in the airplane's flight crew operating manual supplied by UA, in part, stated:

> The main wheels have multidisc brakes that can be actuated by either of two independent brake systems. The normal system uses green hydraulic pressure: the alternate system uses the yellow hydraulic system backed up by a hydraulic accumulator. An anti-skid system and autobraking work through the brake system. Braking commands come from either the brake pedals (pilot action) or the autobrake system (deceleration rate selected by the crew). ... All braking functions (normal and alternate braking control, anti-skid, autobraking, brake temperature indication) are controlled by a two-channel Brake and Steering Control Unit (BSCU). ...
>
> ANTI-SKID SYSTEM
>
> The anti-skid system produces maximum braking efficiency by maintaining the wheels just short of an impending skid. When a wheel is on the verge of locking, the system sends brake release orders to the normal and alternate servovalves - and to the ECAM [electronic centralized aircraft monitoring], which displays the

released brakes. ...

The system compares the speed of each main gear wheel (given by a tachometer) with the speed of the aircraft (reference speed). When the speed of a wheel drops below 0.87 times the reference speed, the system orders brake releasing in order to maintain the brake slip at that value (best braking efficiency).

AUTO BRAKE

The purposes of this system are:

- to reduce the braking distance in case of an aborted takeoff.
- to establish and maintain a selected deceleration rate during landing, thereby improving passenger comfort and reducing crew workload.

ARMING

The system arms when the crew presses the LO, MED, or MAX pushbutton switch if:

- Green pressure is available.
- The anti-skid system has electric power.
- There is no failure in the braking system.
- At least one ADIRS [air data/inertial reference system] is functioning.

ACTIVATION

Automatic braking commences when the ground spoilers extend ... . For autobrakes to activate, at least two SEC's [spoiler elevator computer] must be operative.

DISARMING

The system disarms when:

- Flight crew presses the pushbutton switch or,
- One or more arming conditions is lost or,
- Flight crew applies enough deflection to one brake pedal when autobrake is operating in MAX, MED, or LO mode.
- The ground spoilers retract ... .
- The aircraft has been in flight for 10 seconds.

The airplane maintenance manual stated that "four identical tachometers are installed in the main gear wheel axles (one for each wheel)."

The operator, in part, reported:

> From September 18, 2007 through September 23, 2007, N431UA had a Scheduled Special Route (SSR) maintenance visit accomplished by UA maintenance contractor Triad International Maintenance Corporation (TIMCO). The SSR maintenance visit included accomplishment of UA Change Order Authorization (COA) #405779 "Left Hand Main Landing Gear Sliding Tube Replacement." The aircraft was released from TIMCO on September 23 and subsequently flew 68 cycles. ... A review of maintenance history found that the last time the #1 and #2 anti skid connectors were disturbed was during the SSR visit.

The airplane maintenance manual had a job task that lists procedures for a functional test of the tachometers. That task can show if the identical tachometers have been wired incorrectly. That task is not mandatory if only one of the two tachometers on a main landing gear axle has been replaced or disconnected. The airplane maintenance manual called out that task as soon as more than one of the tachometers had been replaced or disconnected. The COA contained callouts EG7629, EG7630, EG7625, and EG7627, which used the procedures to test for incorrect wiring of the tachometers.

METEOROLOGICAL INFORMATION

At 1551, the ORD weather was: Wind 280 degrees at 14 knots gusting to 19 knots; visibility 10 statute miles; sky condition scattered 25,000; temperature 23 degrees C; dew point 4 degrees C; altimeter 30.06 inches of mercury.

AIRPORT INFORMATION

ORD was located approximately 14 miles northwest of Chicago, Illinois, and was owned and operated by the city of Chicago, Illinois. ORD was a certificated airport under 14 CFR Part 139. ORD 's field elevation was 668 feet above mean sea level. ORD had 6 runways: Runway 14R/32L - 13,000 feet by 200 feet, asphalt/concrete/grooved; runway 10/28 - 10,144 feet by 150 feet, asphalt/concrete/grooved; runway 14L/32R - 10,005 feet by 150 feet, asphalt/concrete/grooved; runway 4R/22L - 8,075 feet by 150 feet, asphalt/grooved; runway 9R/27L - 7,967 feet by 150 feet, asphalt/concrete/grooved; and runway 4L/22R - 7,500 feet by 150 feet, asphalt/grooved.

Runway 22R was marked as a precision approach runway and had high intensity runway edge lights. A four-light, three-degree, precision approach path indicator serviced runway 22R. Runway 22R had MALSR (medium intensity approach lighting system with runway alignment indicator lights) approach lighting. The runway had centerline and touchdown zone lighting.

FLIGHT RECORDERS

Cockpit Voice Recorder

The airplane was equipped cockpit voice recorder (CVR). The CVR was not read out.

Flight Data Recorder

The airplane was equipped with a digital flight data recorder (DFDR). The operator provided a readout of the DFDR data for the landing.

Review of the DFDR data showed that the autobrake system was armed in the low mode on approach. The autobrake system was disarmed when toe pressure was placed on the brake pedals. The recorded aircraft heading showed a drift to the right. The left main landing gear inboard brake went to a high-recorded pressure. The left main landing gear outboard brake pressure went to a low recorded pressure. The data showed the left rudder pedal was depressed and the left brake pedal angle increased. The recorded aircraft heading showed a continued drift to the right. The tiller angle data showed the tiller was turned to the left.

WRECKAGE AND IMPACT INFORMATION

FAA inspectors and representatives of the operator examined the airplane after the incident. The examination found the number one and number two brake anti skid tachometer electrical connectors were reversed.

MEDICAL AND PATHOLOGICAL INFORMATION

FAA required post incident toxicological tests were performed on the flight crew. Both flight crewmembers submitted specimens for drug screening following the incident. The tests were all negative.

TESTS AND RESEARCH

Braking components were sent to their manufacturer for examination and testing.

The examination of the tachometers, part number C20105000, revealed that the number one tachometer, serial number 7318, and the number two tachometer, serial number 7315, exhibited no anomalies that would have precluded operation of the tachometers.

The examination of the servovalves, part number C20374000-2, revealed that the number one servovalve, serial number 50542, and the number two servovalve, serial number 2405, exhibited no anomalies that would have precluded operation of the servovalves.

The examination of the BSCU, part number C202163382-D32, serial number 997, revealed that the unit exhibited no anomalies that would have precluded operation of the BSCU.

The left and right main landing gear (MLG) tires were sent to their manufacturer for examination. The report from the examination showed that the left MLG inboard tire had a large skid-through type abrasion. The tire had a rupture that extended down both sidewalls into the bead areas. The skid abrasion centered around the opposite serial number side shoulder rib area. The left MLG outboard tire had lateral abrasion on the opposite serial

number side shoulder tread rib. The center tread rib had lateral abrasion and rib edge chunking. Most of the tread had lateral scuffmarks. The center tread rib had a cut that was approximately an inch in diameter and extended into the protector ply.

The overhaul facility interviewed their maintenance personnel. The interviews revealed that the 1M and 2M wiring harnesses for the number one and number two tachometers were mislabeled when they were removed for the SSR maintenance. The overhaul facility, in part, reported:

> The Change Order Authorization Job Instruction Card (COAJIC) contained step 26 which directly required the maintenance personnel to perform a build in test equipment (BITE) test of the landing gear in accordance with aircraft maintenance manual (AMM) 32-69-00-740-001. The COJIC contained step 17 which stated, "PREPARE FOR REPLACEMENT OF SLIDING TUBE AS FOLLOWS: ... C.) INSTALL THE TACHOMETERS PER AMM 32-42-57-400-001." The procedure in AMM 32-42-57-400-001 listed step E that stated, "Test (1) Do the functional test of the tachometer (Ref. AMM TASK 32-42-00-720-002)." TASK 32-42-00-720-002 listed the steps necessary to accomplish the functional test of the tachometers. The personnel completing the maintenance thought that the BITE test would confirm proper harness connections. The BITE test did not verify each tachometer's connected position. The BITE test only indicated that a tachometer is connected to the wiring harness and is operational.

ADDITIONAL DATA/INFORMATION

FAA Airworthiness Directive (AD) 2007-11-11, in part, stated:

> This AD results from a determination that additional inspections and mandatory replacement of the main landing gear (MLG) shock absorbers are necessary. We are issuing this AD to detect and correct cracking in an MLG sliding tube, which could result in failure of the sliding tube, loss of one axle, and consequent reduced controllability of the airplane.

Subsequent to Voluntary Disclosure Reporting Program report, UA sent a letter, dated December 10, 2007, to a FAA Certificate Management Office that, in part, reported:

> Documentation associated with COA 405779, which accomplished

> AD2007-11-11 on the LH MLG, and COA 40577A which accomplished AD2007-11-11 on the RH MLG, was found to be unclear regarding the requirement to perform a functional test of the tachometers following their installation. ...
>
> Based on interviews with both Timco ... and United ... maintenance personnel involved with similar activities, it was also determined that the potential for this to occur during the replacement of either MLG also existed. United Work Documents reviewed the LH and RH MLG replacement JIC packages for the Airbus fleet and found the instructions provided to install and functional check the tachometers to be the same as in the COAJICs that accomplished AD2007-11-11. This was inconsistent with the Work Documents Operating Procedures (WDOP) manual and the JIC package was immediately revised to provide proper instructions and ensure that a functional check of each tachometer is performed. To further terminate the conduct that resulted in this apparent violation, and ensure that any aircraft that had maintenance performed on it using either of the COAJICs or the MLG JIC package, we performed functional checks on the tachometers of a total 45 Airbus aircraft per Airbus AMM subtask 32-42-00-720-002 (this included 18 aircraft per EG7662 that have received MLG changes using the JIC package). Of the 45 aircraft checked, only [the incident airplane and another airplane] were found to have been assembled improperly.

According to preliminary information supplied to the NTSB, on February 25, 2008, at 9:16 p.m. MST, United Airlines flight 267, an Airbus A-320, registration N442UA, departed the right side of runway 19 during landing at Jackson Hole Airport, Jackson, Wyoming. Examination of that airplane's left main landing gear brake system revealed that the inboard and outboard wheel speed tachometer wires were cross-connected. The NTSB report number for that incident is DCA08IA044.

The parties to the investigation were the FAA, Triad International Maintenance Corporation, and United Airlines. The French Bureau d' Enquetes et d'Analyses (BEA) provided an accredited representative to the investigation. Airbus Industrie provided a technical representative to the investigation.

Pilot Information

Certificate:	Airline Transport; Commercial; Flight Engineer	**Age:**	57, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without Waivers/Limitations	**Last FAA Medical Exam:**	04/01/2007
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	06/01/2007
Flight Time:	14250 hours (Total, all aircraft), 2450 hours (Total, this make and model), 6450 hours (Pilot In Command, all aircraft), 196 hours (Last 90 days, all aircraft), 75 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Co-Pilot Information

Certificate:	Airline Transport; Flight Instructor; Commercial; Flight Engineer	**Age:**	45, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	Seatbelt, Shoulder harness
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane Multi-engine; Airplane Single-engine; Instrument Airplane	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without Waivers/Limitations	**Last FAA Medical Exam:**	03/01/2007
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	07/01/2007
Flight Time:	10206 hours (Total, all aircraft), 268 hours (Total, this make and model), 6351 hours (Pilot In Command, all aircraft), 141 hours (Last 90 days, all aircraft), 50 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus Industrie	**Registration:**	N431UA
Model/Series:	A320-232	**Aircraft Category:**	Airplane
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Transport	**Serial Number:**	571
Landing Gear Type:	Retractable - Tricycle	**Seats:**	146
Date/Type of Last Inspection:	10/01/2007, Continuous Airworthiness	**Certified Max Gross Wt.:**	169750 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo Fan
Airframe Total Time:	41163 Hours as of last inspection	**Engine Manufacturer:**	IAE
ELT:	Installed	**Engine Model/Series:**	2527
Registered Owner:	U S BANK NA TRUSTEE	**Rated Power:**	26500 lbs
Operator:	UNITED AIR LINES INC	**Operating Certificate(s) Held:**	Flag carrier (121)
Operator Does Business As:		**Operator Designator Code:**	UALA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	**Condition of Light:**	Night
Observation Facility, Elevation:	ORD, 668 ft msl	**Distance from Accident Site:**	
Observation Time:	1951 CDT	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 Miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	17 knots / 23 knots	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	300°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.91 inches Hg	**Temperature/Dew Point:**	16°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	SEATTLE, WA (SEA)	**Type of Flight Plan Filed:**	IFR
Destination:	Chicago, IL	**Type of Clearance:**	IFR
Departure Time:	1649 CDT	**Type of Airspace:**	

Airport Information

Airport:	CHICAGO O'HARE INTL (ORD)	**Runway Surface Type:**	Asphalt
Airport Elevation:	668 ft	**Runway Surface Condition:**	Dry
Runway Used:	22R	**IFR Approach:**	Visual
Runway Length/Width:	7500 ft / 150 ft	**VFR Approach/Landing:**	Full Stop

Wreckage and Impact Information

Crew Injuries:	1 Minor, 4 None	**Aircraft Damage:**	Minor
Passenger Injuries:	1 Minor, 121 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Minor, 125 None	**Latitude, Longitude:**	41.968611, -87.907778 (est)

Administrative Information

Investigator In Charge (IIC):	Edward F Malinowski	**Report Date:**	12/24/2008
Additional Participating Persons:	William W Carmichael; Federal Aviation Administration; Des Plaines, IL Jeff Plantz; United Airlines; Chicago, IL Dave Lattimer; TIMCO Aviation Services, Inc.; Greensboro, NC Philippe Mauviot; French Bureau d' Enquetes et d'Analyses (BEA); Paris, France, Marc Baillion; Airbus Industrie; Blagnac Cedex France,		
Publish Date:	12/24/2008		
Investigation Docket:	NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at http://dms.ntsb.gov/pubdms/.		